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DATA EXCHANGE BETWEEN SIMULATIONS

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INTRODUCTION

This paper discusses the relationships between simulations used in the Air Force decision-making process. Its thrust is to acquaint the reader with the flow of information from a simulation on one level to a simulation on another level which, in turn, uses that information in a different form. Although examples are taken from the Air Force point of view, the paper generally reflects relationships between models used in any decision making process.

BACKGROUND

Within the Air Force and especially within the analysis community, there are a great many simulations or models which are used for a number of different tasks. The Assistant Chief of Staff, Studies and Analyses (AF/SA), has its share which include such computer programs as TAC LANCER, TAC BRAWLER, TAC WARRIOR, TAC ZINGER, STRAT MISSILER[1], etc. Further, there are a number of computer programs which don't have a formal name assigned to them but are nonetheless simulations. The important point to note about all these models is that they have each been designed to give understanding of a particular device, group of devices, tactical situation, or theater confrontation. They vary by subject, and even more important, they vary by the scope or extent to which they model the detail of the elements being simulated.

At one end of the spectrum, we observe the highly detailed model of an element of a weapon system; for example, the simulation of all the particles in an exploding warhead or the emulation of an active radar and signal processor. The next level of simulation tends to be on the system level where we find a non-linear, 6 degree-of-freedom simulation of a modern aircraft. Moving up the scale another step, one might encounter a sophisticated simulation of a 1- aircraft vs 1-aircraft air-to-air engagement. The next logical progression in the chain is a few-on-few engagement model which simulates a dozen or so aircraft, their weapons, and their pilots. The so-called theater model then follows with many aircraft and varied roles to create a simulation of all the activities associated with theater war. Finally, at the other end of the spectrum, one encounters the simulation which represents all the theaters and all the activities associated with the Air Force's overall mission. The one common thread that runs throughout all these simulations is the requirement for valid data, in the proper form, so that the output of the simulation is valid and useful.

SIMULATION/MODEL SCOPE

Most of today's simulations also have common constraints associated with the fact that the majority are digital simulations. This means that the simulations must be compatible with the time and memory constraints of modern mainframe digital processors. Typically, the analyst must consider the turnaround time required to run a simulation and at the same time, the computer storage space available. It seems that analysts and programmers will generally tend to make their simulations as comprehensive as they can until they can either (1) no longer tolerate the turnaround time requirements or (2) no longer fit the data into the machine, or both. The attached graph (first proposed by personnel at the Naval Weapons Center, China Lake, CA) of "The Number of Units Simulated"

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[1]Active simulations in HQ USAF/SA, Pentagon, Wash., DC.

versus "The Number of Lines of Code per Unit" shows that in some sense there are upper and lower limits that relate the size, scope, and detail of modern simulations. The point of this chart is to show graphically that as the scope of a model increases, the fidelity of the description of the elements being modeled must fall off. As the size of the description for an individual unit gets smaller, it becomes more and more difficult to accurately portray the activity and effects of an individual unit. As one tries to capture the attributes of systems within the larger context of more comprehensive models, the need for ever more succinct descriptions of the simulated elements almost invariably causes extreme difficulties in the analytical community.

AGGREGATION PROBLEMS

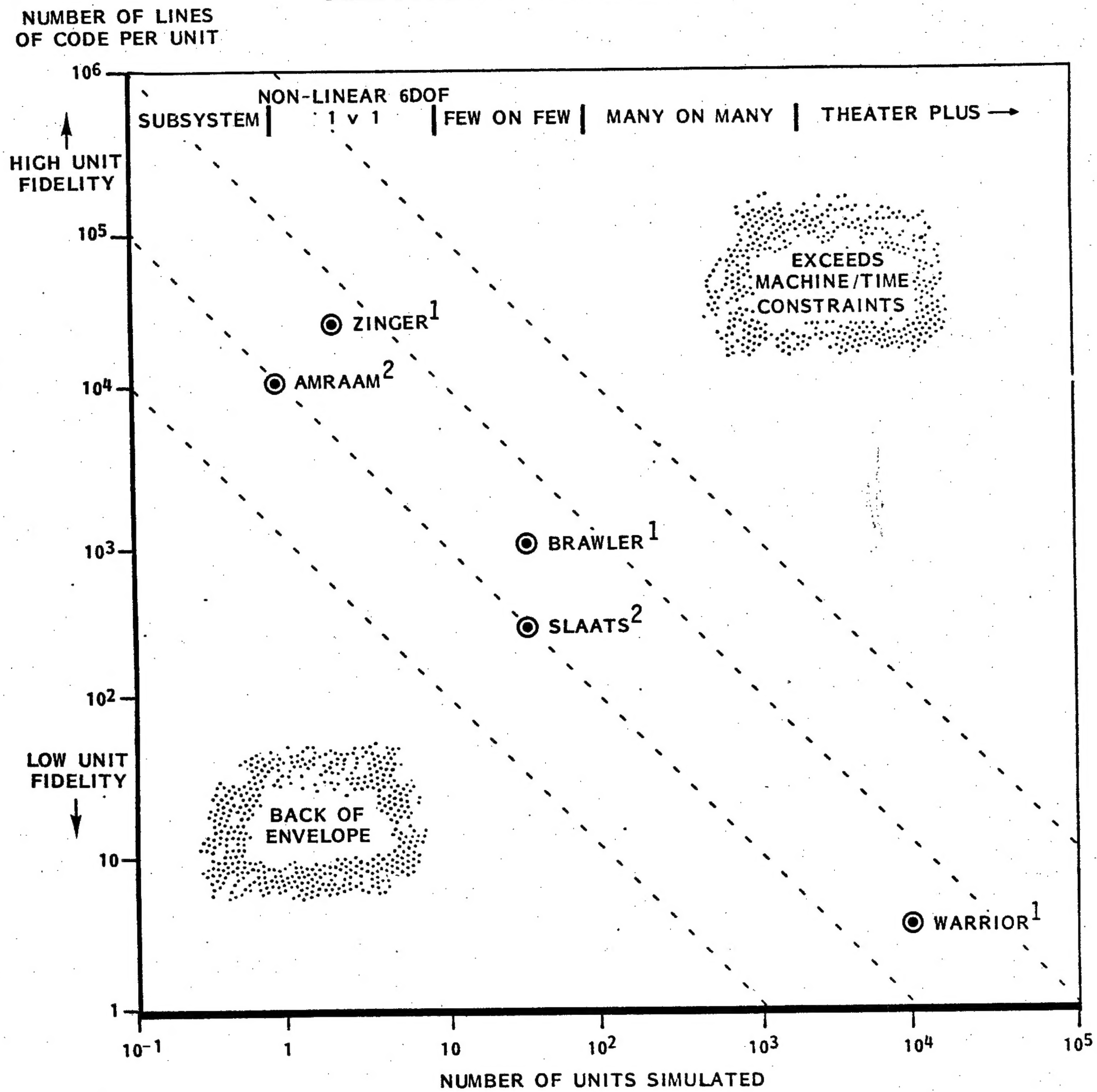
Often, the analyst must get information from one detailed simulation and condense it for insertion into a model with wider scope and less room for detail. This process, which is the first step in using the simulation tool, is critical to the success of the analysis, and requires a great deal of skill and concentration to avoid errors. The most frequent error is that of omission. In this situation, a salient feature of the system or an important attribute of its usage is not included in the description that is put into the simulation. This error can easily occur when a new system is being substituted for an old one, since the model already contains the old description, and it is relatively easy to "upgrade the parameters of the old system to reflect the capabilities." Unfortunately, it is rare that a new system is developed with exactly the same mission as the old. It is far more common to find that the new system will do things that the old one couldn't do, and/or that the utilization of the new system differs from the old. The challenge facing the analyst is that of (1) determining how the new system differs from the old one and (2) validly portraying those differences in the simulation input data. When transitioning data from one simulation to another, one should always ask of the old model: "What did we learn?" One should then ask of the new model: "Did we get it all in?" Ignoring, rejecting, or for any reason not including what is known about a system from all sources is indefensible, but often occurs.

Errors which come from inaccurate modeling are almost impossible to detect by inspection of the simulation output, and yet they frequently undermine the validity of the output to the point that conclusions drawn from the simulation results are unfounded.

SUMMARY

As the scope of a simulation goes up, and thus the unit description fidelity goes down, the tendency is to use the information from that simulation at higher decision levels. It is indeed unfortunate that the very process of generating the aggregated information required for decision making invites omission errors in the modeling process. There is no foolproof method of insuring the validity of a simulation or model, short of exhaustive full scale testing of the phenomena at hand. The risk of undetected errors can be lowered, however, by a strong awareness, among the analysts and the decision makers, of the difficulty and the criticality associated with transitioning data from one simulation to another.

SIZE-FIDELITY RELATIONSHIPS



[1]Active simulations in HQ USAF/SA, Pentagon, Washington, D.C.

[2]Active simulations in AD/YME, Eglin AFB, Florida